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# METHOD AND COMMUNICATIONS SYSTEM FOR REDUCING RADIO TRANSMISSIONS IN WIRELESS COMMUNICATIONS SYSTEMS

[Verfahren und Kommunikationssystem zur Reduzierung der Funkübertragungen in drahtlosen Kommunikationssystemen]

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| Publications Taken into Account for Evaluation of Patentability: | DE 94 13 743 U1<br>U. Pilger: Structure of the DECT Standard. Nachrichtentechn. [Communications Technology], Elektron. [Electronics], Berlin 42, 1992, No. 1, pp. 23-29;<br>"Architecture for a DECT Transmitter and Receiver: A Comparison." NTZ, Vol. 46, 1993, No. 10, pp. 754-757;<br>A. Mann, The GSM Standard. Informatik-Spektrum [Computer Science Spectrum] 14, 1991, pp. 137-151. |

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Pico-cellular, wireless communications systems are predominantly realized according to the DECT (Digital European Cordless Transmission) standard. This DECT standard, which is described in the publication Nachrichtentechnik Elektronik 42 (1992) Jan./Feb., No. 1, "Structure of the DECT Standard," pp. 23-29, sets the transmission protocol used on the bidirectional radio transmission path between a base station and the wirelessly connected communications terminals, as well as the physical properties of the transmitters and receivers forming the radio transmission path. Here, the radio signals are transmitted over the radio transmission path with a transmission frequency of 1.9 GHz, i.e., in the microwave range. Such pico-cellular, wireless communications systems with a limited range of up to ca. 200 m are used predominantly in private communications systems, such as, e.g., private branch exchanges or telephone terminals. In addition, it is known from DE 94 13 743 U1 to provide transmitters and receivers that form a corresponding infrared transmission path instead of transmitters/receivers that form a corresponding radio transmission path. In wireless communications systems with infrared transmission paths, only short transmission ranges can be achieved, and applications are for enclosed spaces.

For some of the users of pico-cellular, wireless communications systems, there is the risk of negative effects on the user during radio connections due to the microwave-range radio signals output from the transmitters.

The invention is based on the task of designing a method and a communications system for reducing radio connections in pico-cellular, wireless communications systems. The task is solved by the features of Claim 1 in terms of the method, and by the features of Claim 7 in terms of the communications system.

Advantageous configurations of the invention are the object of the subordinate claims.

The essential aspect of the method according to Claim 1 is that in pico-cellular, wireless communications systems there is a bidirectional infrared transmission path in addition to the bidirectional radio transmission path, and the transmission quality of the bidirectional infrared transmission path is continuously verified during information exchange. Depending on the verification result, the information exchange is steered over the bidirectional infrared transmission path or the bidirectional radio transmission path, wherein for information exchange over the infrared transmission path, at least the radio transmitters forming the radio transmission path are deactivated.

If information is currently being exchanged over the bidirectional radio transmission path, the transmission quality of the two bidirectional radio [sic; infrared] transmission sub-paths of the infrared transmission path is simultaneously and continuously verified, and for acceptable transmission quality of one or both infrared transmission sub-paths, the information exchange is steered over the bidirectional infrared transmission path, and at least the radio transmitters of the

bidirectional radio transmission path are deactivated - Claim 2. If information is currently being exchanged over the bidirectional infrared transmission path, the transmission quality of the two directional infrared transmission sub-paths of the infrared transmission path is verified, and for unacceptable transmission quality of at least one of the two infrared transmission sub-paths, the information exchange is steered over the bidirectional radio transmission path, wherein the transmission quality of the bidirectional infrared transmission path continues to be verified - Claim 3.

According to another advantageous configuration of the method according to the invention, after a reception of radio signals transmitted over the radio transmission path, the information exchange is steered over the radio transmission path - Claim 4. These measures guarantee that after identification of an unacceptable transmission quality of the infrared transmission path and a changeover to the radio transmission path in the corresponding communications terminal or communications device, a changeover to the radio transmission path is also performed in the other device by transmitting radio signals to the wirelessly-connected communications terminal or communications device.

Through the method according to the invention, an especially advantageous control of the radio transmission path implemented in a pico-cellular, wireless communications system is achieved with an additional infrared transmission path, wherein through the continuous testing of the transmission quality of the infrared transmission path, the radio transmission path is activated only if the transmission quality of the infrared transmission path is no longer acceptable for reliable transmission of the digitized telephone signals. Analogously, the infrared transmission path is activated again if the transmission quality of the infrared transmission path becomes acceptable again. This means that in enclosed spaces, such as, e.g., in offices or living rooms, the wireless transmission of the digitized telephone signals is steered over infrared transmission paths and in open space or in other spaces not equipped with infrared transmission means, the wireless transmission is automatically steered over a radio transmission path. Through the method according to the invention, radio connections are reduced considerably during information exchange in pico-cellular, wireless communications systems through the changeover to additional infrared transmission paths, and possible effects on the users of pico-cellular, wireless communications systems due to radio signals formed in the microwave range for the radio connections are reduced. Another advantage of the method according to the invention is that with a reduction in radio transmissions, due to the lower transmission power of infrared transmission paths relative to radio transmission paths, the average energy consumption in the communications terminals is lower and consequently smaller energy storage devices can be used, or a longer operating time can be achieved with the same energy storage devices. Smaller rechargeable or non-rechargeable energy storage devices also reduce the weight and the size of

the communications terminals, even taking into consideration the additional components forming the bidirectional infrared transmission path.

In the other Claims 8-18, especially advantageous configurations of a communications system for reducing radio transmissions in a pico-cellular, wireless communications system are disclosed, wherein infrared transmitters/receivers are provided for forming the infrared transmission path and priority means are provided for verifying the transmission quality of the infrared transmission path as well as the changeover of information exchange from the infrared to the radio transmission path and vice versa.

In the following, the method according to the invention is explained in more detail with reference to a block circuit diagram and a flow chart. Shown are

Figure 1, a pico-cellular, wireless communications system realized according to the method according to the invention, and

Figure 2, the method according to the invention realized in the components of the pico-cellular, wireless communications system from Figure 1.

The block circuit diagram shows a communications terminal KE, which can be connected wirelessly to one of the communications devices K. The communications terminal KE is shown as a representative of several communications terminals that can be associated with one of the illustrated communications devices K. A communications device K is realized by another communications terminal KEE, a base station BS of a wireless telephone system, a branch telephone exchange KA, in particular a private branch exchange, or by a system converter UE. The other communications device KEE is connected, as indicated by the dashed line, to the branch telephone exchange KA, for example. The other communications terminal KEE represents, e.g., a telephone terminal of a public or private telephone network, wherein the other communications terminal KEE is connected to a public or private branch telephone exchange or telephone system.

The illustrated base station BS can likewise be connected, as indicated by the dashed line, to the branch telephone exchange KA, for example. Wireless branch telephone terminals can be connected to the base station BS.

For the embodiment, it is assumed that the illustrated communications terminal KE is wirelessly associated with the other communications terminal KEE. In the following, the components necessary for realizing the method according to the invention in the communications terminal KE and in the other communications terminal KEE are explained. Both the communications terminal KE and also the other communications terminal KEE each have an antenna A, those being connected wirelessly over the bidirectional radio transmission path FUS. The radio transmission path FUS is indicated by two bidirectional radio transmission sub-paths (TFUS), indicated in Figure 1 by the designation in parentheses. Over the radio transmission path

FUS or between the communications terminal KE and the other communications terminal KEE, radio signals fs are transmitted bidirectionally, e.g., according to the DECT standard. According to the DECT standard, the radio signals fs have a frequency of 1835-1932 MHz depending on the transmission direction and the transmission channel that is used. In addition, the digitized voice signals are inserted into a time-multiplex structured stream and transmitted to the wirelessly connected communications devices K. To realize the radio transmission path FUS, the antenna A is connected to a transmitter/receiver SE-FU. In this device, the incoming, digital voice signals sp, which are time-multiplex oriented according to the DECT standard, are converted into DECT-compliant radio signals fs and vice versa. Realizations of such transmitter/receivers SU-FU are described in the publication NTZ, Vol. 46, 1993, No. 10, pp. 754-757 "Architectures for a DECT Transmitter and Receiver: A Comparison." Alternatively, the radio transmitter/receiver SE-FU and the antenna A can be realized, not according to the DECT standard, but rather according to another transmission protocol tailored to a pico-cellular communications system and corresponding physical properties.

In addition, both in the communications terminal KE and also in the other communications terminal KEE, there is a bidirectional infrared transmitter/receiver unit ISE forming a bidirectional infrared transmission path IUS. An infrared transmission path IUS is formed by two bidirectional infrared transmission sub-paths (TIUS) - indicated in Figure 1 by the designation in parentheses. An infrared transmitter/receiver unit ISE is realized by an infrared transmitter diode and an infrared receiver diode iIn a known way. Alternatively, the infrared transmitter/receiver unit ISE can be realized as a standalone infrared transmitter/receiver unit ISEA, i.e., separate from the communications device K, as indicated in Figure 1 by dashed blocks. The separate infrared transmitter/receiver unit ISEA is advantageously used in communications systems for which the communications device K and the communications terminal KE are arranged in different spaces or buildings. Both the integrated and also the separate infrared transmitter/receiver units ISE, ISEA are each connected to an infrared transmitter/receiver device SE-IN. In this infrared transmitter/receiver device SE-IN, infrared signals ist that can be transmitted over the infrared transmission path IUS are modulated, or the infrared signals is transmitted over the infrared transmission path IUS are demodulated, by the digital, time-multiplex structured voice signals sp formed according to the DECT standard.

Both transmitter/receiver devices SE-FU, SE-IN are respectively connected over a bidirectional connection V to a priority controller PST. This priority controller PST on the one hand converts the digitized voice signals sp, formed according to the DECT standard, coming in or going out over the infrared transmission path IUS or radio transmission path FUS, and on the other hand, together with the infrared transmitter/receiver device SE-IN, (verifies) the transmission quality of the bidirectional infrared transmission path IUS. This is achieved, e.g., by

measuring the level of the received infrared signals is in the infrared transmitter/receiver device SE-IN and transmitting the measurement result over another connection L to the priority controller PST where it is evaluated. If the level of the infrared signals is exceeds or falls below a predetermined value, the current information exchange is steered either over the infrared transmission path IUS or the radio transmission path FUS. Alternatively, measurement of the signal-to-noise ratio of the received infrared signals is can also be considered for measurement of the transmission quality. In this case, the measurement result is likewise transmitted over the other connection L to the priority controller PST, where it is evaluated. For an acceptable signal-to-noise ratio, the information exchange is steered over the infrared transmission path IUS, and for an unacceptable ratio, the current information exchange is steered over the radio transmission path FUS. For this purpose, there is a changeover device, not shown, in the priority controller PST. In addition, the priority controller PST monitors whether radio signals fs are received over the radio transmission path FUS. If this is the case, then the outgoing digital voice signals fs formed according to the DECT standard are likewise steered over the radio transmission path FUS. This changeover is necessary because if radio signals fs are received, it is to be assumed that at there is not acceptable transmission quality of the infrared transmission path IUS the wirelessly connected communications device K or communications terminal KE and that the information exchange has been steered onto the radio transmission path FUS.

The branch telephone exchange KA, the base station BS, and the system converter UE are configured the same as the other communications terminal KEE with reference to the method according to the invention, i.e., with an antenna A, an infrared transmitter/receiver unit ISE, an infrared transmitter/receiver device SE-IN, a radio transmitter/receiver device SE-FU, and a priority controller PST.

In the system converter UE, the priority controller is connected to a conversion unit UH. In this conversion unit UH, e.g., the voice signals sp formed according to the DECT standard are converted into voice signals spg formed according to the GSM standard, wherein the digitized voice signals remain unchanged and are merely removed, e.g., from one standardized transmission frame and inserted into another standardized transmission frame. The essential properties of the GSM standard are described in the publication Informatikspektrum 14 (1991) June, No. 3, pp. 137-152 "The GSM Standard." According to the GSM standard, the digitized voice signals are likewise inserted in a multiplex structure into the transmission frame, wherein the frame length is matched to the transmission rate of 890-960 MHz. Advantageously, this conversion unit UH is realized by a microprocessor unit, since digital DECT voice signals sp are converted into digital GSM voice signals spg. The conversion unit UH is connected to a transmitter/receiver device SE-GSM realized according to the GSM standard. In this transmitter/receiver device SE-GSM, the digitized voice signals sp, which are time-multiplex

structured according to the GSM standard, are transformed into high-frequency radio signals fsg corresponding to the GSM standard and transmitted over an antenna AG provided for this purpose to another, not-shown, communications device of a communications system realized according to the GSM standard, wherein this communications device is wirelessly connected to the system converter UE. Analogously, for this purpose radio signals fsg received according to the GSM standard are converted into digital, GSM-standard compliant voice signals spg. The conversion device is used especially advantageously in motor vehicles in order to obtain access to a wireless, macro-cellular communications system realized, e.g., according to the GSM standard, over a communications terminal realized according to the DECT standard, wherein the wireless, macro-cellular communications system is matched to the requirements of the moving motor vehicle (e.g., handoff at a vehicle speed of 200 km/h) in terms of transmission power and methods. Here, the information exchange is automatically steered over the infrared transmission path IUS, which exhibits minimal effects on the user, within the motor vehicle, and over the radio transmission path FUS in the near range outside of the motor vehicle. Furthermore, through the reduction of radio transmissions, as previously explained, the average energy consumption is reduced, whereby lighter and smaller communications terminals can be designed, or longer operating times or longer talk times can be achieved during battery or accumulator operation. The information exchange is simultaneously realized over the wireless connection to the communications system realized according to the GSM standard via the conversion unit UH and the GSM transmitter/receiver device SE-GSM. The antenna A of the GSM transmitter/receiver device SE-GSM and the antenna AG of the transmitter/receiver device SE-FU are arranged outside of the motor vehicle. In addition to reducing possible effects on the user due to radio signals - in the microwave range - formed by the radio transmitters use of the system converter UE also enables considerable reduction of, effects on the motor vehicle electronics (e.g., in the airbag). Alternatively, system converters UE can be realized with a conversion unit and a transmitter/receiver device that are adapted to other wireless communications systems operating according to other standards or transmission protocols and other transmission properties. For the realization of GSM or alternative transmitter/receiver devices SE-GSM, there are components related to switching and programming for each wireless communications system. For the conversion of the digitized DECT voice signals sp into GSM or alternative digital voice signals spg, a microprocessor system is advantageously used.

Figure 2 shows an essentially self-explanatory flow chart that is implemented in the priority controllers PST, realized, e.g., by a microprocessor, and in partial in the infrared transmitter/receiver devices IUS [sic; SE-IN]. The illustrated procedure, advantageously realized in a program is started at the beginning of information exchange, i.e., at the beginning of a voice connection in each of the affected communications terminals KE or communications devices K,

and is repeated cyclically in the sense of scanning of the measured values indicating the transmission quality of the infrared transmission path IUS up to the end of the information exchange. As an alternative, which is not shown, interrupt-colntrolled, program-related realizations are possible, wherein here the procedure or a sub-procedure starts when a measured value exceeds or falls below a predetermined value depending on the current information exchange, and ends after the procedure.

Claims

1. Method for reducing radio transmissions during information exchange in a pico-cellular, wireless communications system, in which a communications device (K) can be connected over a pico-cellular, bidirectional radio transmission path to at least one wireless communications terminal (KE),

- for which a bidirectional infrared transmission path (IUS) is provided in addition to each bidirectional radio transmission path (FUS),

- for which during information exchange the transmission quality of the bidirectional infrared transmission path (IUS) is continuously verified and the information exchange is steered, depending on the verification result, over

- the bidirectional infrared transmission path (IUS) or

- the bidirectional radio transmission path (FUS),

wherein for information exchange over the infrared transmission path (IUS), at least the radio transmitters (SE-FU) forming the radio transmission path (FUS) are deactivated.

2. Method according to Claim 1, characterized in that if information is currently being exchanged over the bidirectional radio transmission path (FUS), the transmission quality of the two bidirectional infrared transmission sub-paths (TIUS) of the infrared transmission path (TIUS [sic; IUS]) is simultaneously and continuously verified, and for an acceptable transmission quality of one or both infrared transmission sub-paths (TIUS), the information exchange is steered over the bidirectional infrared transmission path (IUS), wherein at least the radio transmitters (SE-FU) of the bidirectional radio transmission path (FUS) are deactivated.

3. Method according to Claim 1, characterized in that if information is currently being exchanged over the bidirectional infrared transmission path (IUS), the transmission quality of the two bidirectional infrared transmission sub-paths (TIUS) of the infrared transmission path (IUS) is continuously verified, and for an unacceptable transmission quality on at least one of the two infrared transmission sub-paths (TIUS) the information exchange is steered over the bidirectional radio transmission path (FUS), wherein the transmission quality of the bidirectional infrared transmission path (IUS) continues to be verified.

4. Method according to one of Claims 1-3, characterized in that after reception of radio signals (fs) transmitted over the radio transmission path (FUS), the information exchange is steered over the radio transmission path (FUS).

5. Method according to one of Claims 1-4, characterized in that pico-cellular information (sp) formed in the communications device (K) is converted into micro-cellular or macro-cellular information (spg) and vice versa, and the converted information (spg) is transmitted wirelessly to a micro-cellular or macro-cellular wireless communications system or is received by this system with the help of additional transmitter/receiver means (AG, SE-GSM).

6. Method according to one of Claims 1-5, characterized in that the pico-cellular, wireless communications system is realized according to the DECT standard.

7. Communications system for reducing radio transmissions during information exchange in a pico-cellular, wireless communications system with at least one communications terminal (KE) that can be connected over a pico-cellular radio transmission path (FUS), wherein in the communications device (K), and in at least one communications terminal (KE), there are radio transmission means (A, SE-FU) forming a pico-cellular, bidirectional radio transmission path (FUS),

- for which in the communications device (K) and in one or more communications terminals (KE) there are also infrared transmission means (ISE, SE-IN) forming a bidirectional infrared transmission path (IUS) and priority means (PST), and are configured such that

- during information exchange, the transmission quality of the bidirectional infrared transmission path (IUS) is continuously verified, and depending on the verification result the information exchange is steered over

- the bidirectional infrared transmission path (IUS) or

- the bidirectional radio transmission path (FUS),

wherein during information exchange over the infrared transmission path (IUS) at least the radio transmitters (SE-FU) forming the radio transmission path (FUS) are deactivated.

8. Communications system according to Claim 7, characterized in that the communications device (K) and one or more communications terminal (KE) are configured such that if information is currently being exchanged over the bidirectional radio transmission path (FUS), the transmission quality of the two bidirectional infrared transmission sub-paths (TIUS) of the infrared transmission path (IUS) is simultaneously and continuously verified with the help of the priority means (PST) and a part of the infrared transmission means (SE-IN), and for an acceptable transmission quality of both or one of the infrared transmission sub-paths (TIUS), the information exchange is steered over the bidirectional infrared transmission path (FUS [sic; IUS]), wherein at least the radio transmitters (SE-FU) of the bidirectional radio transmission path (FUS) are deactivated.

9. Communications system according to Claim 7, characterized in that the communications device (K) and one or more communications terminals (KE) are configured such that if information is exchanged over the bidirectional infrared transmission path (IUS) with the help of the priority means (PST) and the infrared transmission means (ISE, SE-IN), the transmission quality of both bidirectional infrared transmission sub-paths (TIUS) of the infrared transmission path (IUS) is continuously verified, and for an unacceptable transmission quality of at least one of the two infrared transmission sub-paths (TIUS) the information exchange is steered over the bidirectional radio transmission path (FUS), wherein the transmission quality of the bidirectional infrared transmission path (IUS) continues to be verified.

10. Communications system according to one of Claims 7-9, characterized in that the communications device (K) and one or more communications terminals (KE) are configured such that after reception of radio signals (fs) transmitted over the radio transmission path (FUS), the information exchange is steered over the radio transmission path (FUS).

11. Communications system according to one of Claims 7-10, characterized in that the infrared transmission means (ISEA) associated with the communications device (K) are arranged separately from the communications device (K) and are connected to this device by connection lines (VL).

12. Communications system according to Claim 11, characterized in that the separate infrared transmission means (ISEA) are arranged in the main useable area of the wireless communications terminals (KE).

13. Communications system according to one of Claims 7-12, characterized in that the communications device (K) is realized by a communications terminal connected to a branch telephone exchange (KA).

14. Communications system according to one of Claims 7-12, characterized in that the communications device (K) is realized by a base station (BS) of a wireless communications system.

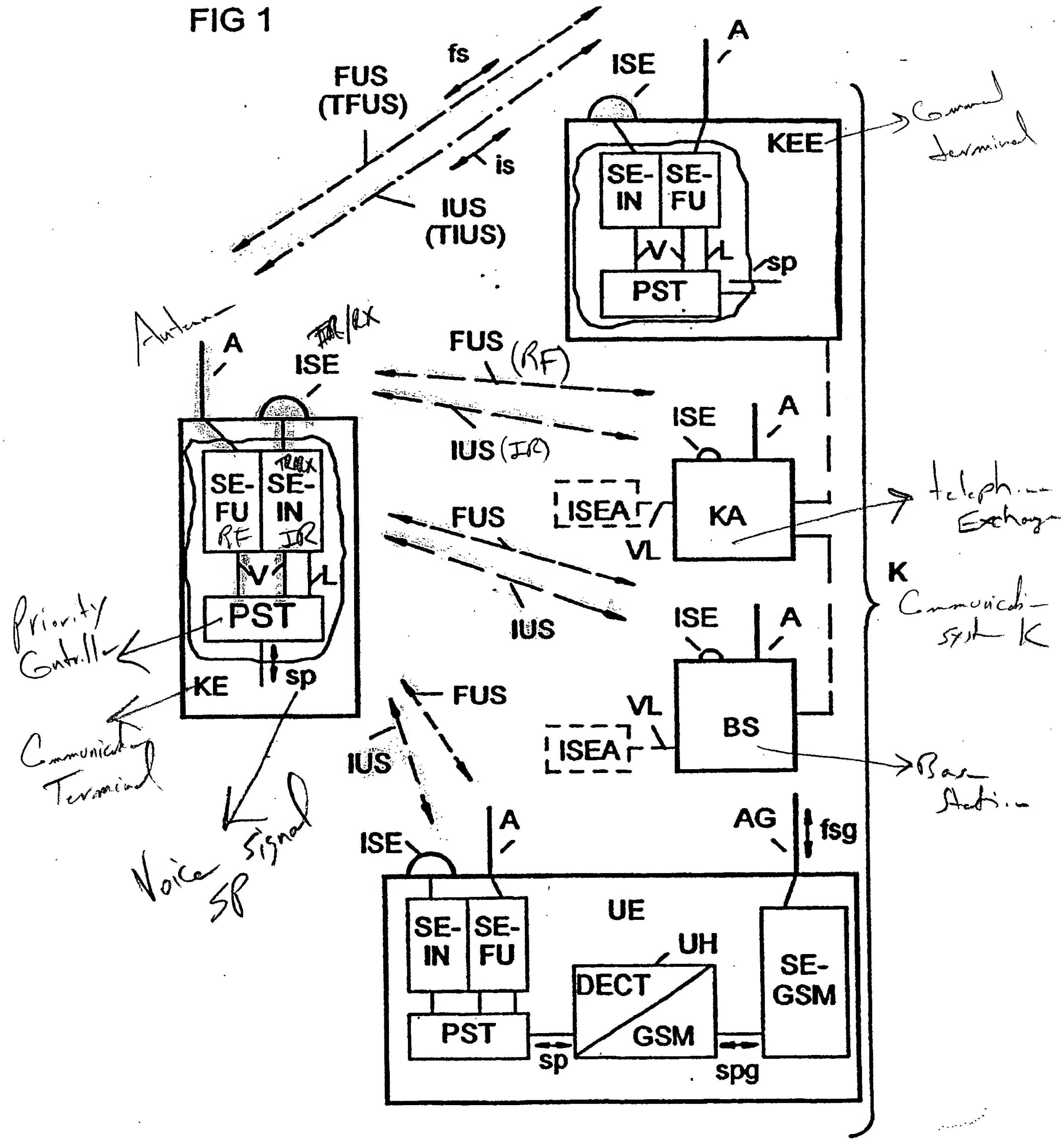
15. Communications system according to one of Claims 7-12, characterized in that the communications device (K) is realized by a branch telephone exchange (KA).

16. Communications system according to one of Claims 7-12, characterized in that the communications device (K) is realized by a system converter (UE), there are means (UH) in the system converter (UE) for converting the pico-cellular information (sp) into micro-cellular or macro-cellular information (spg) and vice versa, and there are additional transmitter/receiver means (AG, SE-GSM) in the system converter (UE) for wireless connection to a micro-cellular or a macro-cellular wireless communications system.

17. Communications system according to Claim 16, characterized in that the micro-cellular or macro-cellular wireless communications system is realized according to the GSM standard.

18. Communications system according to one of Claims 7-17, characterized in that the pico-cellular, wireless communications system is realized according to the DECT standard.

FIG 1



fs
FUS
(TFUS)
is
IUS
(TIUS)
A
ISE
KEE
Command terminal
SE-
IN
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FU
V
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Antenna
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ISE
FUS (RF)
IUS (IR)
ISE
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SE-
FU
RF
TR/RX
SE-
IN
IR
V
L
PST
ISEA
VL
KA
Telephone Exchange
FUS
IUS
K
Communication system K
ISE
A
Priority Controller
KE
sp
Communication Terminal
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VL
BS
ISEA
Base Station
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Voice Signal sp
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SE-
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DECT
GSM
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sp
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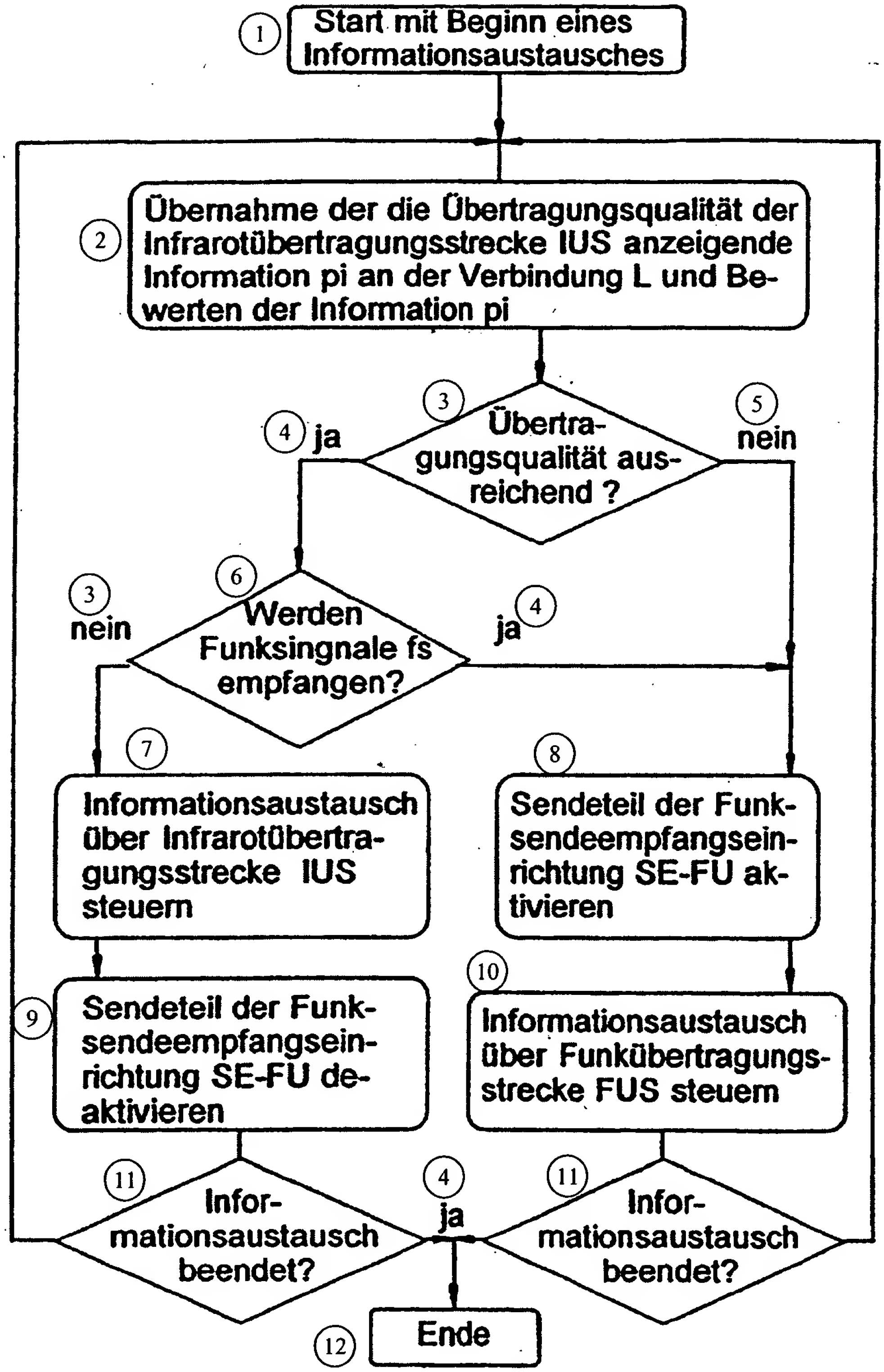
FIG 2


1
Start mit Beginn eines Informationsaustausches
2
Übernahme der die Übertragungsqualität der Infrarotübertragungsstrecke IUS anzeigende Information pi an der Verbindung L und Bewerten der Information pi
3
Übertragungsqualität ausreichend ?
4 ja
5 nein
6
Werden Funksingnale fs empfangen?
3 nein
4 ja
7
Informationsaustausch über Infrarotübertragungsstrecke IUS steuern
8
Sendeteil der Funksendeempfangseinrichtung SE-FU aktivieren
9
Sendeteil der Funksendeempfangseinrichtung SE-FU deaktivieren
10
Informationsaustausch über Funkübertragungsstrecke FUS steuern
11
Informationsaustausch beendet?
4 ja
11
Informationsaustausch beendet?
12
Ende

Key:
1 Start with beginning of information exchange
2 Transfer of the information pi indicating the transmission quality of the infrared transmission path IUS on the connection L and evaluation of the information pi
3 Transmission quality acceptable?
4 Yes
5 No
6 Have radio signals fs been received?
7 Steer information exchange over infrared transmission path IUS
8 Activate transmission part of radio transmitter/receiver device SE-FU
9 Deactivate transmission part of radio transmitter/receiver device SE-FU
10 Steer information exchange over radio transmission path FUS
11 End of information exchange?
12 End